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Application of Moringa Leaf Extract as A Seed Priming Agent on Seed Germination

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Abstract
Commercial growth enhancers have proven to be highly effective in promoting the growth and development of crop plants, especially under the challenging conditions associated with chilling stress. These enhancers are often costly and may not always be easily accessible to all farmers. In this regard, the leaves of Moringa oleifera L. present a noteworthy alternative. Rich in various beneficial compounds, such as zeatin, ascorbate, phenolic compounds, calcium, and potassium, Moringa leaves provide a natural solution for enhancing crop growth. This study aims to explore the growth-promoting effects of Moringa oleifera L. leaf extract, specifically focusing on its impact on the germination rates of Allium cepa L. and Abelmoschus esculentus L. To evaluate these effects, different concentrations of Moringa leaf extracts—25%, 50%, 75%, and 100%—were systematically applied and compared to a control group that received distilled water. The results demonstrate that the aqueous extracts of Moringa oleifera L. significantly enhance seed germination and positively influence various growth parameters, including shoot length and root length. Furthermore, the vigour index of the tested species shows considerable improvement. Notably, the growth-enhancing effects become more pronounced at higher concentrations of Moringa oleifera L. This study emphasises the significant differences in concentration levels and their complex interactions concerning the specific growth parameters investigated, highlighting the potential of Moringa oleifera L. as an effective and accessible growth enhancer for crops.

Keywords: Moringa oleifera L., Leaf extract, Priming, Enhancer, Concentration

1. INTRODUCTION

Moringa oleifera L. is an exceptional plant native to the stunning Himalayan region of Indo-Pakistan, thriving in a variety of ecological conditions. This remarkable species comprises three distinct landraces, each with its unique features. The white-seeded moringa impresses with its lush, oval leaves that form a dense canopy and its elegant, creamy white pods that dangle from sturdy branches. In contrast, the black-seeded moringa stands out with its dark, glossy seeds and robust growth habit, showcasing its resilience in the environment. The esteemed PKM1 variety is particularly valued for its impressive yield and adaptability, making it a top choice for cultivation.

Moringa oleifera L., also known as the drumstick tree or miracle tree, is a remarkable plant from the Brassica order and the Moringaceae family. It features feathery leaves and long seed pods, which are harvested for culinary use. Boasting a high nutritional profile, it is rich in vitamins C and A, calcium, potassium, and protein, making it a valuable food source globally. The leaves, pods, and flowers are used in various dishes, and the dried leaves can be powdered to enhance meals. Traditionally, Moringa has been utilised for its medicinal properties, treating inflammation and digestive issues. Its adaptability and rapid growth make it an accessible resource, especially in developing regions, and it is recognised for its potential to combat malnutrition and improve public health. Moringa oleifera L. is thus important for enhancing health and nutrition worldwide[1].

Moringa oleifera, also known as the drumstick tree or miracle tree, is a highly nutritious plant with over 90 bioactive compounds. It plays a crucial role in tropical regions as a food source to combat malnutrition, particularly in children and infants. Edible parts like leaves, pods, and seeds are commonly used in cooking, helping to enhance nutrition and health in local communities[2,3].

Plants adapt to cold by adjusting gene transcription for low molecular weight proteins that help them survive stress. The effectiveness of these proteins varies by species, highlighting different evolutionary adaptations. Understanding these mechanisms is important for agriculture and conservation in a changing climate[4-7].

2. Materials and Methods

In this study, we investigated the growth-promoting effects of a nutrient solution derived from Moringa oleifera L. litter on two crops: Allium cepa L. (onion) and Abelmoschus esculentus L. (okra). We focused on key aspects of plant development, including seed germination and seedling growth. Our research included monitoring enzyme activity during germination to understand the biochemical interactions influenced by the Moringa solution. We will describe the materials used, the composition of the nutrient solution, and our experimental methods, aiming to explore Moringa oleifera L. as an organic growth stimulator in agriculture.

1 Agronomical features of test crop cultivators

Allium cepa L. (Onion)

This advanced onion cultivar is distinguished by its remarkably high-yielding vigour, making it an increasingly favoured option among farmers. Renowned for its ability to produce abundant, large bulbs, this variety thrives under a range of soil conditions and climatic environments. Its resilience against common pests and diseases further enhances its appeal, allowing for a more consistent and sustainable harvest. Farmers value its vigorous growth rate and adaptability, as it not only maximises their crop yields but also contributes to improved overall farm productivity. With this cultivar, growers can expect a flavourful, high-quality onion that meets market demands while ensuring their agricultural success.

Abelmoschus esculentus L. (Ladyfinger or Okra)

Okra, scientifically known as Abelmoschus esculentus L., is one of the most widely cultivated crops worldwide. This green, elongated vegetable is highly prized not only for its unique texture and flavour but also for its impressive nutritional profile. Rich in vitamins A and C, folate, and dietary fibre, okra serves as an excellent source of plant-based protein, making it an essential addition to a balanced diet. Moreover, it contains antioxidants that contribute to overall health and may promote digestive health due to its high fibre content. As a versatile ingredient, okra can be prepared in various ways, including frying, steaming, or incorporating it into soups and stews, making it a staple in many cuisines around the globe.

Collection and selection of seeds

Pure line seeds from the specified cultivators were procured from the District Agriculture Office in Rayagada. A rigorous selection process was conducted to identify seeds that exhibited optimal health and demonstrated uniformity in colour, size, and shape. These selected seeds were appropriate for use in this investigation, reflecting a high standard of quality essential for the research.

Collection of plant materials

Fresh leaves of the Moringa oleifera L. plant were systematically collected from the agricultural fields close to the Rayagada Autonomous College, Rayagada. This collection was conducted to ensure the quality and integrity of the samples for further research and analysis.

Preparation of Moringa oleifera L. Aqueous leaf extract

Figure 1: Preparation of Moringa oleifera L. Aqueous leaf extract

The process commenced with the careful collection of Moringa oleifera L. leaves, which were thoroughly washed under running water to eliminate any dirt and impurities. Once cleaned, the leaves were spread out and air-dried at room temperature for a full seven days, allowing them to lose moisture and become completely crisp. After this drying period, the leaves were ground into a fine powder using a suitable grinder to achieve a consistent mixture. For the extraction, exactly 100 grams of the leaf powder were measured and combined with 1 litre of distilled water in a clean beaker. This mixture was stirred vigorously to facilitate the infusion of the beneficial compounds from the leaves into the water. The beaker was then allowed to sit undisturbed at room temperature for 24 hours to maximise extraction. Following this infusion period, the mixture was meticulously filtered through fine muslin cloth to separate the liquid from the leaf residue, resulting in a rich, concentrated stock solution infused with the powerful active components of Moringa oleifera L.

Preparation of selected crop species for laboratory study

During the experimental procedure, twenty uniform seeds from each species were carefully placed in the designated Petri dishes. Each dish was sequentially assigned one of the five concentration levels of leaf extract, receiving 10 ml of the chosen solution. The control dishes were similarly treated with 10 ml of distilled water. Each Petri dish was clearly labelled to indicate both the species and the specific concentration used. Once all seeds had been placed and watered, the Petri dishes were positioned in a growth chamber held at room temperature to ensure optimal conditions for germination. They were monitored closely until the final germination count was recorded, providing valuable data on the effects of the different concentrations of leaf extract on seed germination.

Figure 2: Preparation of selected crop for germination

Germination and bioassay studies

We studied the effect of different concentrations on seed germination rates by assessing them on the tenth day of incubation. We recorded germination percentages and measured the lengths of shoots and roots. For accuracy, we randomly selected ten seedlings from each treatment group. If fewer than 10% of the seeds grow, we use all the seedlings to get more results.

3. Results

The results of the effects of aqueous extract of leaves of M. oleifera L. on germination and seedling growth are presented below.

Effect of leaf extract on Allium cepa L. seed germination

In the control treatment, seed germination was 60%, indicating 40% inhibition due to moderate stress. At a 25% treatment concentration, germination rose to 78%, reducing inhibition to 22%. At 50%, germination improved further to 87% with only 13% inhibition. The 75% treatment level saw germination soar to 94% and inhibition drop to 6%. Finally, at 100%, germination reached a perfect 100% with no inhibition, highlighting the positive impact of higher treatment concentrations on seed germination rates.

Treatment	% germination	% inhibition in germination
Control	60	40
25%	78	22
50%	87	13
75%	94	06
100%	100	-

Table 1 Effect of M. oleifera L. Leaf extract on germination and seedling growth of Allium cepa L. on the 10th day after sowing

Concentration	2nd day	4th day	6th day	8th day	10th day	Mean value
Control	0	0.1	0.6	1.3	2.2	0.84
25%	0.1	0.4	1.1	1.8	2.5	1.18
50%	0.5	1.1	1.7	2.6	3.0	1.78
75%	0.9	1.5	2.1	3.1	3.8	2.28
100%	1.4	2.1	2.9	3.7	4.3	2.88

Table 2: The effect of leaf extract of M. oleifera L. on the shoot length (in cm) of Allium cepa L. after 10 days of treatment

Concentration	2nd day	4th day	6th day	8th day	10th day	Mean value
Control	0	0.3	1.2	2.1	3.1	1.34
25%	0.9	1.3	1.9	2.6	3.8	2.1
50%	1.7	2.2	2.8	3.1	4.1	2.78
75%	2.1	2.8	3.3	3.8	4.6	3.32
100%	2.4	3.0	3.7	4.2	5.2	3.7

Table 3 The effect of leaf extract of M. oleifera L. on the root length (in cm) of Allium cepa L. after 10 days of treatment

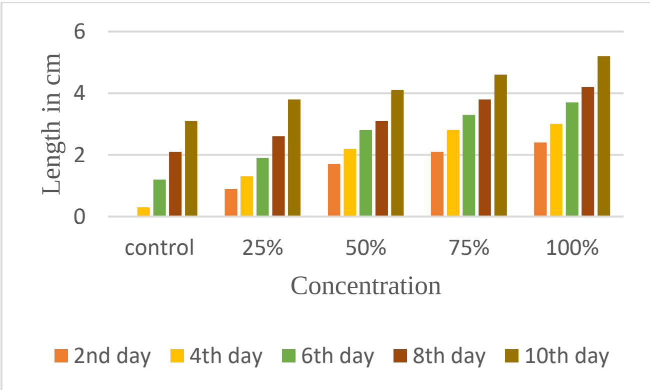

Figure 3 Graphical representation of the effect of leaf extract of M. oleifera L. on the shoot length of Allium cepa L. after 10 days of treatment

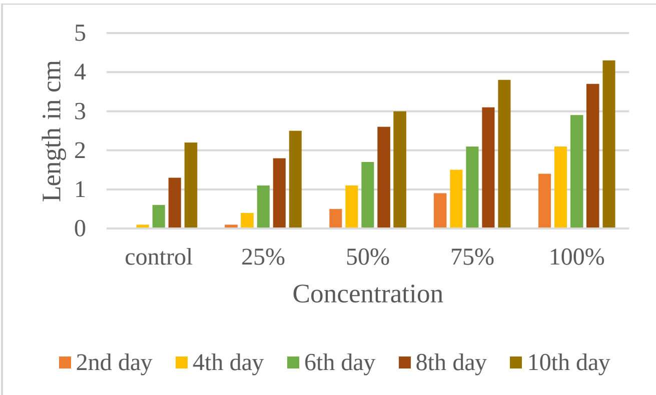

Figure 4 Graphical representation of the effect of leaf extract of M. oleifera L. on the Root length of Allium cepa L. after 10 days of treatment

- **Effect of leaf extract on Abelmoschus esculentus L.**

In the control treatment, seeds germinated at 54%, with 46% facing challenges. Increasing the treatment to 25% improved germination to 69%, and at 50%, it reached 79%. With 75% treatment, germination rose to 89%, and at 100%, all seeds germinated, achieving a 100% success rate. This data shows a clear positive relationship between treatment levels and seed viability.

Treatment	% germination	% inhibition in germination
Control	54	46
25%	69	31
50%	79	21
75%	89	11
100%	100	-

Table 4 Effect of M. oleifera L. Leaf extract on germination and seedling growth of Abelmoschus esculentus L. on the 10th day after showing

Concentration	2nd day	4th day	6th day	8th day	10th day	Mean value
Control	0.1	0.4	0.8	1.4	1.9	0.92
25%	0.7	1.6	2.2	2.9	3.4	2.16
50%	1.1	1.8	2.6	3.2	3.9	2.52
75%	1.7	2.2	2.8	3.5	4.3	2.9
100%	2	2.6	3.2	3.8	4.9	3.3

Table 5: The effect of leaf extract of M. oleifera L. on the Shoot length (in cm) of Abelmoschus esculentus L. after 10 days of treatment

Concentration	2nd day	4th day	6th day	8th day	10th day	Mean value
Control	0	0.2	0.6	1.1	1.7	0.72
25%	0.3	0.9	1.3	1.8	2.6	1.38
50%	0.7	1.2	1.8	2.5	3.1	1.86
75%	1.1	1.7	2.4	2.9	3.8	2.38
100%	1.6	2.2	2.8	3.5	4.2	2.86

Table 6: The effect of leaf extract of M. oleifera L. on the Root length (in cm) of Abelmoschus esculentus L. after 10 days of treatment

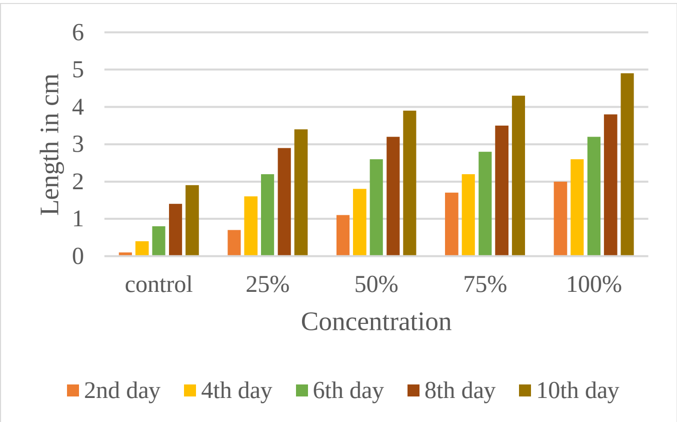

Figure 5: Graphical representation of the effect of leaf extract of M. oleifera L. on the shoot length of Abelmoschus esculentus L. after 10 days of treatment

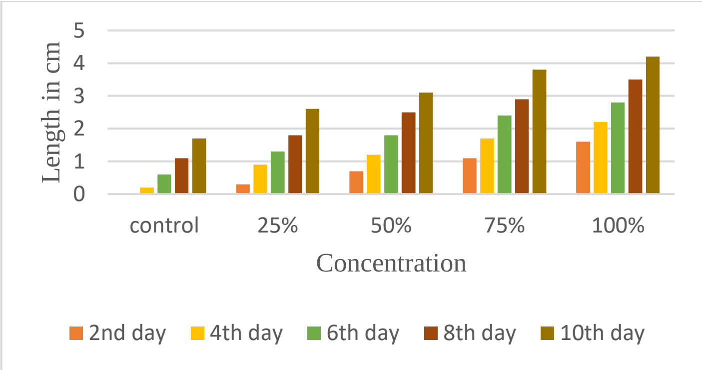

Figure 6: Graphical representation of the effect of leaf extract of M. oleifera L. on the root length of Abelmoschus esculentus L. after 10 days of treatment

4. Discussion

Moringa leaf extract (MLE) is an effective natural seed priming agent derived from Moringa oleifera leaves. Used at a 3% concentration, it enhances seed germination and boosts the vigour and resilience of crops, particularly in challenging conditions like drought or poor soil. Incorporating MLE can significantly improve crop yields and contribute to sustainable agricultural practices.

Antioxidants enhance a plant's ability to cope with abiotic stressors like drought and extreme temperatures. In this study, using micronutrient leaf extracts (MLES) increased antioxidant activity, which protects plant cells from oxidative damage caused by stress. Under stressful conditions, antioxidants are produced at higher levels, helping to counteract reactive oxygen species (ROS) and maintain cellular integrity. This strengthened antioxidant defence system protects essential cellular structures and contributes to better plant health and resilience[8].

5. Conclusion

This study investigates the effects of seed priming on germination and growth in Allium cepa L. (onion) and Abelmoschus esculentus L. (okra), revealing inhibited root and shoot elongation. In contrast, Moringa oleifera L. extract promotes growth, highlighting its potential for developing beneficial bioactive compounds in agriculture. The research shows that seed priming with Moringa leaf extract enhances seed emergence rates and seedling vigour, crucial for successful crop cultivation. Effective priming techniques can improve consistency in seed performance and contribute to better crop yields, offering valuable insights for farmers looking to optimise their planting strategies.

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